

CONFIDENTIAL

998415

Declass Review by NGA.

NPIC/TSSG/DEB-1052-68
31 January 1968

MEMORANDUM FOR: Chief, Contract Administration and Settlement Branch, PD

ATTENTION :

SUBJECT :

1. On 25 June 1965, NPIC entered into the subject contract with [] to design and fabricate a prototype Improved Anamorphic Viewing System. The contract incorporates the General Provisions, Section A and the Cost Reimbursement Research and Development Provisions, Section E.

2. NPIC has been informed by the Contracting Officer that the General Provisions dated January 1965 were the provisions in force at the time of the contract and are those that are included in the Contract. Article 18, subsection (i) states, "the Government may duplicate and disclose reports and disclosures of Subject Inventions required to be furnished by the Contractor or a subcontractor pursuant to this Patent Rights clause." Article 17 requires the Contractor to obtain written approval prior to filing a patent application; therefore, the disclosure must be furnished to the Contracting Officer.

3. [] has filed the attached patent application. Because of the rights granted under the above mentioned Articles, NPIC is in the process of making the attached application available to another Contractor, who is required to incorporate a similar anamorphic system into an instrument that is being developed for NPIC. This procedure of furnishing the information derived under the subject contract, prevents the costly process of inventing the same anamorphic system twice.

4. The attached drawing was furnished in the fifth monthly report--a deliverable item--therefore, under Article 20 subsection (a) this drawing is also being furnished to the Contractor.

5. This memorandum is for information purposes; however, if there is disagreement relative to the outlined interpretation of the Government's rights in this matter, it is requested that NPIC be so informed.

[]
Acting Assistant for Technical Development,
NPIC

Distribution:

Orig & 1 - Addressee
2 - TSSG/AC
✓2 - TSSG/ESB

NPIC/TSSG/ESB

Approved For Release 2004/11/30 : CIA-RDP78B04770A000400020005-2

CONFIDENTIAL

GROUP 1
Excluded from automatic
downgrading and
declassification

25X1

Approved For Release 2004/11/30 : CIA-RDP78B04770A000400020005-2

Approved For Release 2004/11/30 : CIA-RDP78B04770A000400020005-2

DESIGN ANALYSIS
PROGRAM FOR
STUDY, DESIGN AND FABRICATION
OF
ANAMORPHIC VIEWING SYSTEM

DESIGN ANALYSIS
PROGRAM FOR
STUDY, DESIGN AND FABRICATION
OF
ANAMORPHIC VIEWING SYSTEM

September 27, 1965



25X1

1.0 INTRODUCTION

The design study portion of the program for Study, Design and Manufacture of a Variable Anamorphic Viewing System has been carried far enough to clearly indicate the best solution for this problem. This design analysis report reviews the various possibilities that were evaluated. The reasons for rejection of systems considered unacceptable are reported, and the reasons for selection of the accepted system are given.

The study effort necessary to reach this point has involved much less mechanical layout and preliminary design work than originally estimated. Thus a portion of the funds originally allocated to the study phase remain unspent. This is mentioned only to avoid possible interpretation of this under-expenditure as failure to achieve all the objectives of the proposed study effort. It is our feeling that all worthwhile techniques of achieving variable anamorphism have been evaluated, and thus the study objective has been met. Since funds are available the study is continuing during evaluation of the design analysis. This continued effort is for the purpose of evaluating some of the minor problems in the selected technique.

2.0 VARIABLE ANAMORPHIC SYSTEMS

Before discussing the various systems studied, it may be well to briefly review the design goals of the viewing system. It is to have an anamorphic magnification adjustable from 1 to 2.2X with a basic (at the 1X position) 10X spherical power. Anamorphic direction is to be adjustable through 360° , and the eyepoint is to be elevated no more than four inches above that of the normal Zoom 70. While not part of the specification, a consideration has been to minimize longitudinal separation of the exit pupils (one in the anamorphic direction and one perpendicular to it) and as a design goal a maximum value of 4 mm has been adopted. Loss of field is to be 15% maximum and loss of resolution on axis shall be no more than 20%.

2.1 Major Modification of Zoom 70

In Section 2.3 of the Interim Progress Report several possible modifications of the Zoom 70 mirror cluster arrangement were discussed. These were centered on the possibility of using a negative collimating lens, and constructing an anamorphic viewing system working in collimated light. This would be similar to the unit previously built but the negative collimating lens would result in a final erect image. Study showed that with the mirror cluster in place there was no position of the collimating lens that did not lead to excessive loss of field. Removal of the mirror cluster yielded an inverted image from the microscope and eliminated the need for a negative collimating lens.

With the mirror cluster removed, a viewing system inverting the image is required. Thus the principles of the previous unit were applicable. A system based on this concept was laid out first order wise. To reduce the eyepoint

extension a short focal length positive objective lens was placed behind the zoom portion of the Zoom 70 system. This formed a nearby, reduced image of the object. This image was then collimated by a short focal length collimator and a following de-collimator lens formed a real image for viewing with a conventional eyepiece. The general arrangement is shown in figure 1. The zoom system (not shown) fits between the collimator and de-collimator. A two mirror rhomb arrangement provides the same viewing angle as the conventional instrument, and at the same time provides interpupillary adjustment.

A first order optical design was obtained. It was difficult to find a zoom system that would fit in the available space. One was found, but there was some question whether the full zoom range would be obtainable when thicknesses appropriate to the final design were inserted.

Also this represented a major modification of the Zoom 70 that could be accomplished only at the factory. A system requiring less drastic or no modification is desirable. This coupled with the question of whether the full zoom range could be achieved was cause for rejection of this approach. Of the various techniques involving major modification, this was the most favorable. Since it was considered unsatisfactory, it was concluded that major modification would not yield a satisfactory solution.

2.2 Simple Anamorphic Zoom

This system consists of a simple cylindrical zoom operating in the convergent beam leaving the mirror cluster. Ideally this type of system forms a variable image in the same plane as the objective image plane. This image is then viewed with a conventional eyepiece.

A question arises as to whether the cylinder system can be corrected when used in convergent light. At the time the Interim Progress Report was written there were indications such correction could be achieved. Since then accurate ray trace analysis has shown that the convergence of the beam reaching the Zoom 70 eyepiece focal plane is so small that those aberrations unique to a cylinder system in convergent light do not appear. Thus aberration correction is possible.

No zoom system could be found that positioned its image at the same plane as the object. Thus cylinders crossed with the zoom system were necessary to obtain images from the power and no power plane of the zoom system at a common point. All the systems of this type suffered from longitudinal pupil displacement.

In addition, to retain an erect image it was necessary that these systems form a virtual image that lay within the lens system. In none of the systems was it possible to get this image within an inch of the last lens so it could be viewed with a conventional 10X eyepiece. Thus it would have been necessary to use a lower power eyepiece and obtain the required 10X power by having the minimum power of the cylinder system greater than unity. The increased magnification of the zoom system caused an unsatisfactory reduction in field coverage. This coupled with the pupil problem was cause for rejection of this approach.

2.3 Rotating Cylinders

It is a well known principle of optics that the refraction by two cylinder lens with power planes at an arbitrary angle to each other is equivalent to refraction by a spherical lens plus a cylinder lens. Further, the distribution of power between the spherical and cylinder component is a function

of the angle between the axes. This is easily seen in the limiting cases of parallel and perpendicular power planes. In the former case the refraction is purely cylindrical while in the latter case the refraction is equivalent to that of a sphere of power $2F_a$, plus a cylinder power of $F_b - F_a$ where a is the smaller of the two cylinder powers F_a and F_b . In theory then it appeared possible that two sets of counter-rotating cylinders separated by some distance could be made to operate as a variable power cylinder system while at the same time acting as a fixed power spherical system.

Investigation of this type of system showed that two sets of counter-rotating cylinders was inadequate, and that three were required. Unfortunately it turned out that in addition to counter-rotation, longitudinal motion of the lens assemblies was also required. Figure 2 shows the relative position of object, image and three counter-rotating cylinder lens subassemblies for a zoom range of 2.2 to 1. It is seen that this solution requires the eyepiece to be at least 55 mm from the image. Thus at best a 5X eyepiece could be used, and to obtain the required 10X power would have involved developing a system having a basic magnification of 2X with the attendant field problems.

Figure 3 shows the necessary power in two perpendicular planes for the second lens assembly. The point of interest, which is typical of all three lens assemblies, is that these powers start changing in one direction, reverse and then move in the opposite direction. This means that to achieve the desired zoom, the lenses must rotate in one direction, stop, and reverse their direction of rotation. During this rotation, they must also move longitudinally. The mechanics to achieve this motion become quite complex.

There was also a serious problem with shift of the exit pupil in one plane while the exit pupil of the other plane remained relatively stationary.

It must be admitted that this was only one solution of this type, and other solutions might have alleviated some of these problems. It seemed doubtful, however, that all of the undersirable characteristics would be eliminated. An exhaustive evaluation of what could be accomplished with this system would require more time than the schedule permitted. In addition, the final design to correct aberrations would necessitate development of new procedures. This also would seriously delay the schedule.

As a consequence, while it was felt that this technique might ultimately lead to a useful system, it was decided that the potential delay of the schedule did not justify the possible advantages of the system. The investigation was therefore stopped. It may be desirable, inasmuch as Phase I study funds are available, to continue the investigation of this type of system during the Phase II design effort. This study would have value only for future programs, since results would be obtained too late for the present effort. The system does show enough promise that it should be more fully investigated.

2.4 Modification of Previous System

As the study progressed it became increasingly clear that the original concept of a collimating lens, an afocal zoom system, and a de-collimating lens offered many advantages. An effort was made to evolve a similar system which corrected the previous disadvantages of an inverted image and excessive length.

Much of the length of the previous system resulted from the long focal length of the collimator and de-collimator lenses. This focal length was determined by the desire to keep the field angle of the collimated bundle small in order to maintain field coverage. One way to reduce this length would

be to introduce a device having a long optical length and a short physical length. A Pechan prism is such a device. Further, such a prism reverts the image, and thus two of them at right angles would invert the image.

The logical conclusion of this type of reasoning is a system consisting of a field lens, a Pechan prism, a collimator, zoom system, de-collimator (or objective) lens, a second Pechan prism at ninety degrees to the first one, and perhaps a second field lens. The final image to be viewed by a conventional eyepiece. The general arrangement is shown in figure 4.

Preliminary layout has shown that the system easily fits within the desired four inches. Final overall length can be determined only after the particular zoom system to be used has been selected. Using the four inch maximum length and the necessary Pechan prism and collimator lens thicknesses there is some 40 mm available for the zoom system.

[If desired, it will be feasible to make the upper Pechan rotatable so that the unit will add the versatility of image rotation to the Zoom 70.] 6000

It does not appear at present that the unit will be directly interchangeable with a conventional eyepiece. The modification will, however, be the relatively simple task of unscrewing the eyepiece focus sleeve adapter, and replacing it with a sleeve to be furnished with the unit. This can be done in the field without difficulty by relatively unskilled operators.

This system is superior in every way to all the other alternatives studied. This is the one that is selected for Phase II design and manufacture.

3.0 FUTURE PLANS

Technically, a suitable system having been selected for final design, the study phase of the program is finished. Alternatively only a general configuration has been selected. Inasmuch as funds are available, the study is continuing to select the most suitable afocal zoom system for use in this arrangement. Selection will be based on minimizing overall length, and on simplifying the mechanical arrangement to achieve zoom and anamorphic rotation. This effort will be kept at a relatively low level until design plan approval is obtained.

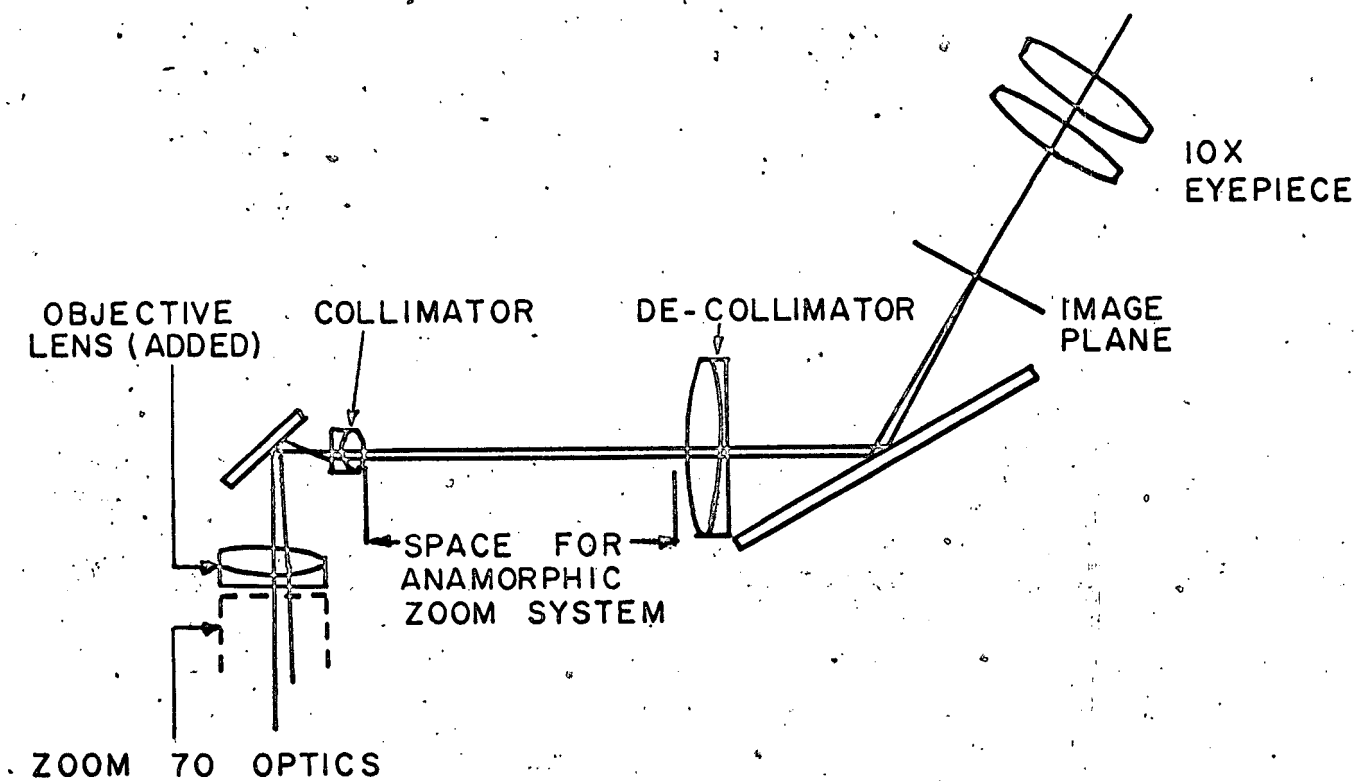


FIG. 1 MOST FAVORABLE SYSTEM
REQUIRING MAJOR MODIFICATION
OF ZOOM 70.

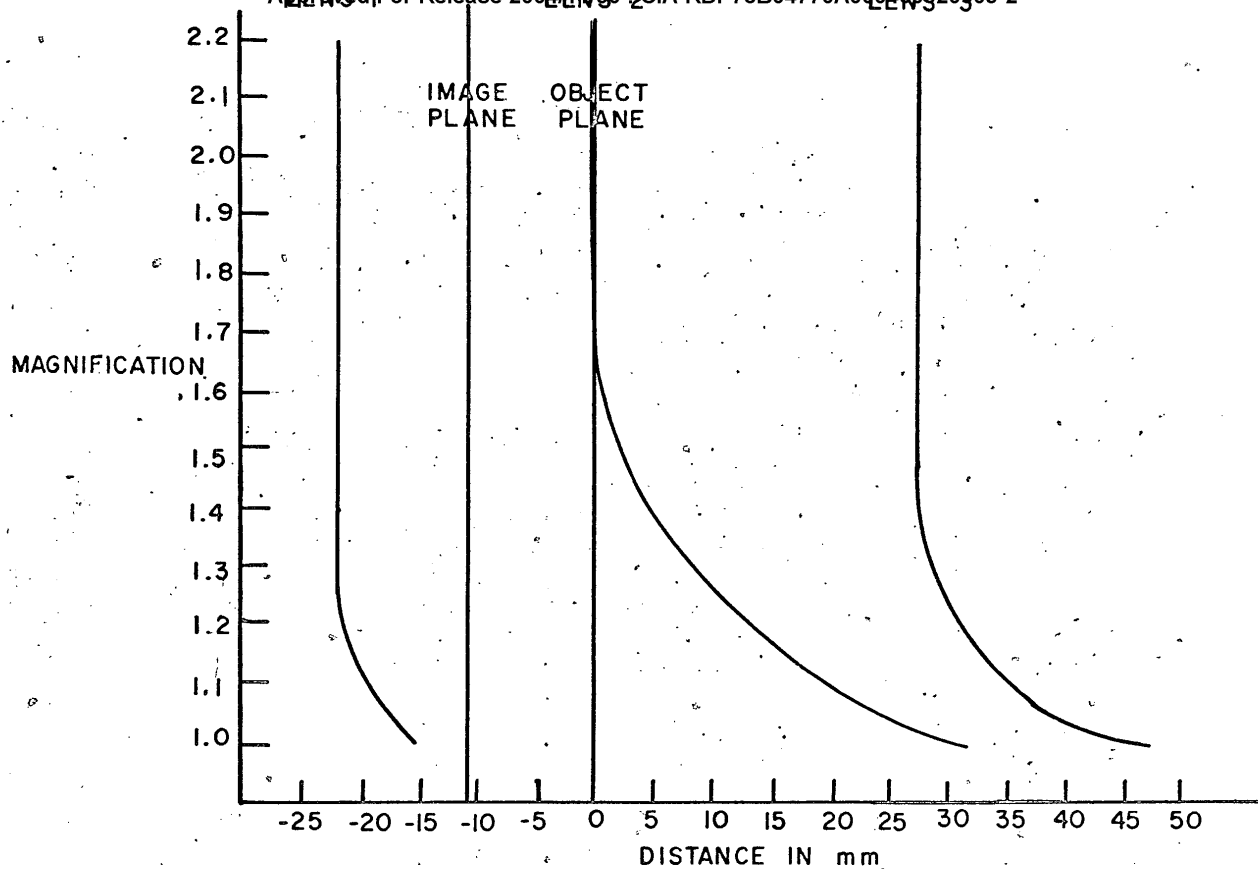


FIG. 2 POSITION OF COUNTER ROTATING CYLINDER LENS ASSEMBLIES FOR 2.2 TO 1 ANAMORPHIC ZOOM SYSTEM

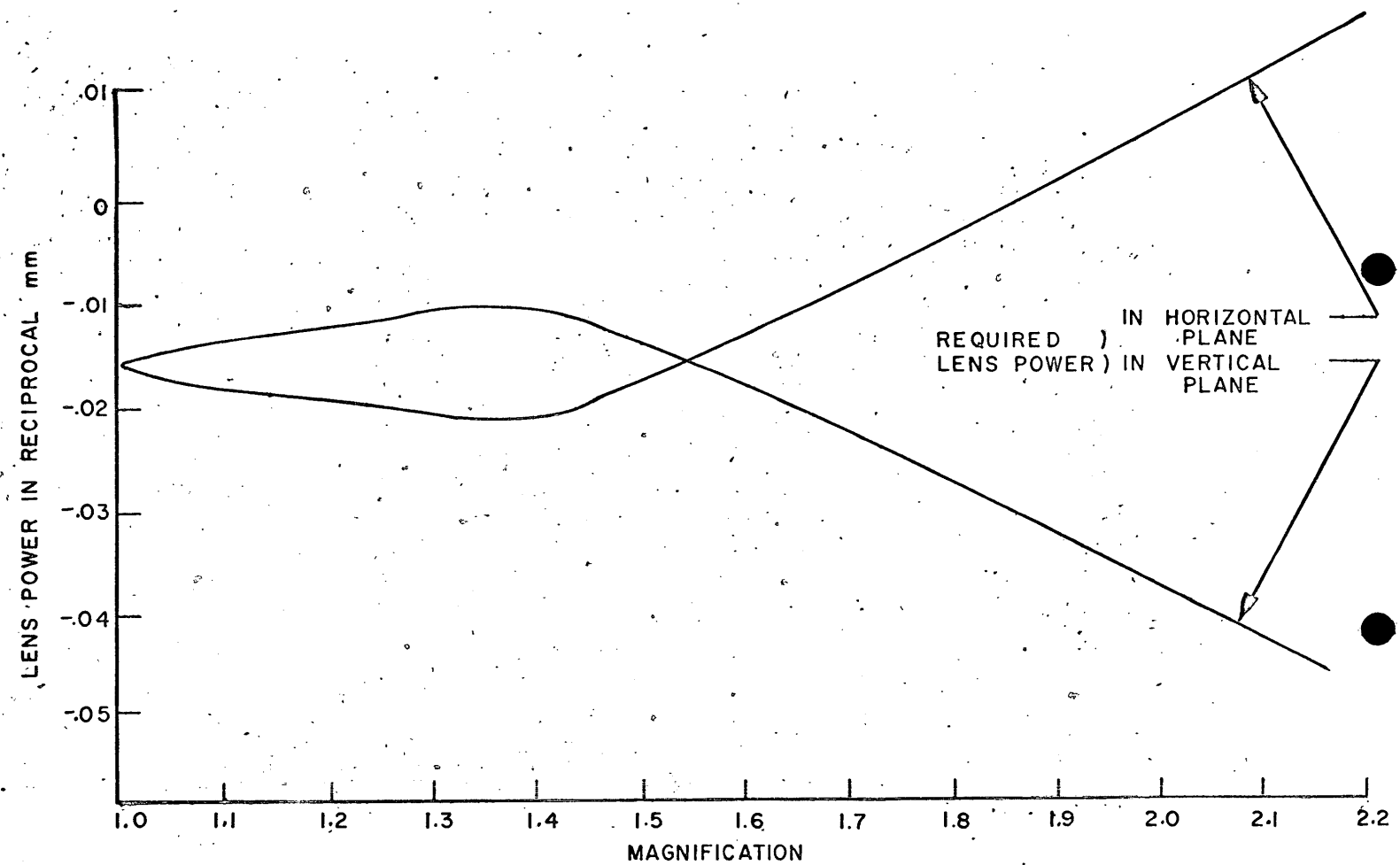


FIG. 3 REQUIRED HORIZONTAL AND VERTICAL LENS POWERS FOR LENS 2 OF FIGURE 2 AS A FUNCTION OF MAGNIFICATION

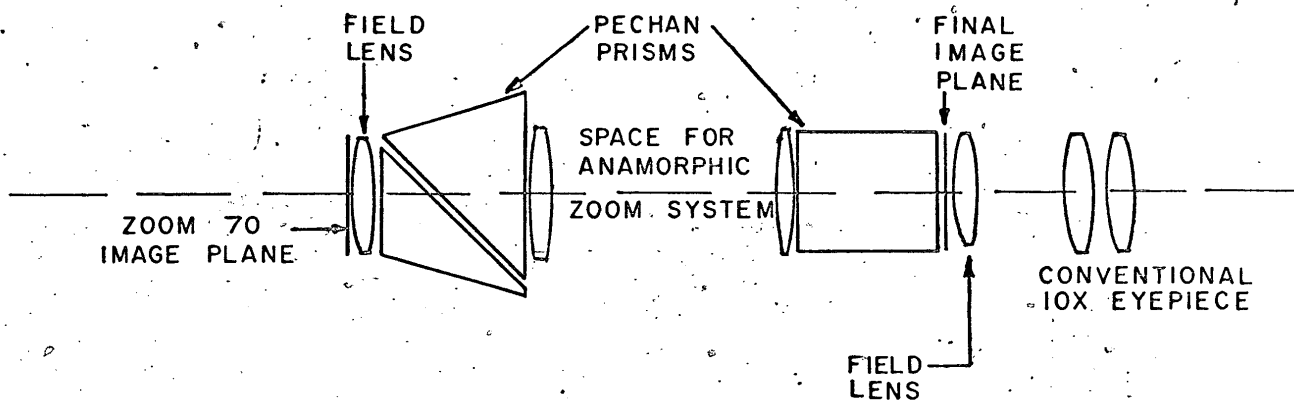


FIG.4 SCHEMATIC LAYOUT OF VARIABLE ANAMORPHIC VIEWING SYSTEM SELECTED FOR DESIGN AND FABRICATION

998.415

SECRET
(When Filled In)

SPEED LETTER	REPLY REQUESTED		DATE
	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO	7 JUNE 1967
TO : NPIC		FROM: OL/PD/CB/CAS	
ATTN: [REDACTED]		ENC. LETTER & INVENTORY REPORT	

Type #1 — The attached property report has been received from [REDACTED] on Contract [REDACTED] Task Order [REDACTED]. To facilitate final settlement of this contract, you are requested to answer each of the following categories:

Type #2 — Please indicate if this report appears reasonable. For your convenience, circle one YES NO. If NO indicate below -----

Type #3 — Does the Contractor have any other items of Government property, either hand carried or delivered in his possession that has not been reported? For your convenience, circle one YES NO. If YES indicate below -----

Type #4 — Indicate by circling the appropriate disposition instructions: ACCEPT OFFER ABANDON RETURN TRANSFER OTHER. If "Return," "Transfer," or "Other," indicate below -----

Type #5 — Indicate below any additional comments that may help this case act upon the attached report. Please sign and date your reply.

[REDACTED]

Contract Administrator

SIGNATURE

REPLY	DATE
-------	------

PLEASE INSTRUCT THE CONTRACTOR TO FORWARD ALL THE EQUIPMENT LISTED ON THE ATTACHED SHEET TO NPIC. IT SHOULD BE SPECIFICALLY TRANSFERRED TO [REDACTED] EXPLOSION DEVELOPMENT LABORATORY, ROOM 4A411. THIS EQUIPMENT WILL BE USED FOR INHOUSE DEVELOPMENT WORK.

[REDACTED]

INVENTORY SCHEDULE B

Approved For Release 2004/11/30 : CIA-RDP78B04770A000400020005-2

TERMINATION ☐ NON-TERMINATION ☒FORM APPROVED.
BUDGET BUREAU NO. 22-R0RAW MATERIALS (OTHER THAN METALS) ☐ PURCHASED PARTS ☐ FINISHED COMPONENTS ☒ FINISHED PRODUCT ☐ MISCEL. LANEWAYS ☐

PROPERTY CLASSIFICATION (SEE INSTRUCTION ON REVERSE)

No Commercial Value

PAGE NO. 1 NUMBER OF PAGES 1

THIS SCHEDULE APPLIES TO (CHECK ONE)

☒ A PRIME CONTRACT WITH THE GOVERNMENT ☐ SUBCONTRACT(S) OR PURCHASE ORDER(S)

CONTRACTOR WHO SENT NOTICE OF TERMINATION

NAME
U. S. GovernmentADDRESS
Washington, D.C.PRODUCT COVERED BY CONTRACT OR ORDER
Anamorphic Eyepiece

SUBCONTRACT OR P.O. NO.

REFERENCE
5399021-039

S&RG

FOR USE OF CONTRACTING AGENCY ONLY	ITEM NO.	DESCRIPTION (IF PROPERTY HAS COMMERCIAL VALUE, FURNISH ADEQUATE COMMERCIAL DESCRIPTION. (SEE INSTR.). OTHERWISE, FURNISH DESCRIPTION SUFFICIENT TO ENABLE CONTRACTING OFFICER OR AUTHORIZED CONTRACTOR TO DETERMINE APPROPRIATE DISPOSITION THEREOF. WHERE PRACTICABLE, SHOW MANUFACTURER'S NAME, ADDRESS AND CATALOG NUMBER. WHERE COLS. D1 AND D2 ARE NOT APPLICABLE, WRITE COL. B ENTRY ACROSS THE TWO COLS.)	GOVERNMENT CONTRACT OR DRAWING NUMBER AND REV. NUMBER (B1)	UNIT OF PACKING (BULK, BLS., CRATES, ETC.) (B2)	CONSTRUCTION CODE (USE CODE) (C)	QUANTITY (D)	UNIT OF MEASURE (D1)	COST (FOR FINISHED PRODUCT, SHOW CONTRACT PRICE INSTEAD OF COST)		CONTRACTOR'S OFFER OR PROCEEDS OF SALE (G)	FOR USE OF CONTRACTING AGENCY ONLY
								UNIT (E)	TOTAL (F)		
	1	Pechan Prism	5399021-039		N1	1	each				25
	2	" "			N1	1	"				
	3	Locking Ring			S	2	"				

INVENTORY SCHEDULE CERTIFICATE

The undersigned, individually and as an authorized representative of the Contractor, certifies that he has examined this Inventory Schedule, page numbers 1 to 1 inclusive, dated 5/22/67 and that in the exercise of his best judgment and to the best of his knowledge, based upon information believed by him to be reliable, said Schedule has been prepared in accordance with applicable instructions; that the inventory described therein is allocable to the designated contract and is located at the places specified; if the property reported therein is termination inventory, that the quantities are not in excess of the reasonable quantitative requirements of the terminated portion of the contract; that said Schedule does not include any items reasonably usable, without loss to the Contractor, on its

other work; that the costs shown on such Schedules are in accordance with the Contractor's books of account and that the prices shown in column (F) representing the proceeds of authorized sale of the items covered thereby, are fair and reasonable.

The Contractor agrees to inform the Contracting Officer of any substantial change in the status of the inventory shown in this Schedule between the date hereof and the final disposition of such inventory.

Subject to any authorized prior disposition, title to the inventory listed in this Schedule is hereby tendered to the Government and is warranted to be free and clear of all liens and encumbrances.

NAME OF CONTRACTOR

BY (SIGNATURE OF AUTHORIZED OFFICIAL)

TITLE

Controller

DATE

5/22/67

Manager, Product Cost Accounting

Approved For Release 2004/11/30 : CIA-RDP78B04770A000400020005-2

EDITION OF 1 JUL 61, IS OBSOLETE.

INVENTORY SCHEDULE B

Approved For Release 2004/11/30 : CIA-RDP78B04770A000400020005-2

FORM APPROVED.
GUGGET BUREAU NO. 22-R07

THIS SCHEDULE APPLIES TO (CHECK ONE)

☐ RAW MATERIALS
(OTHER THAN METALS) ☐ PURCHASED
PARTS ☒ FINISHED
COMPONENTS ☐ FINISHED
PRODUCT ☐ MISCEL-
LANEOUS

PROPERTY CLASSIFICATION (SEE INSTRUCTION ON REVERS 1)

No Commercial Value

PAGE NO. 1
NUMBER OF PAGE 1

25

☒ A PRIME CONTRACT WITH THE GOVERNMENT ☐ SUBCONTRACT(S) OR PURCHASE ORDER(S)

CONTRACTOR WHO SENT NOTICE OF TERMINATION

NAME
U. S. GovernmentADDRESS
Washington, D.C.

PRODUCT COVERED BY CONTRACT OR ORDER

Anamorphic Eyeplate

GOVERNMENT PRIME CONTRACT NO.

SUBCONTRACT OR P.O. NO.

REFERENCE NO.

512-39340

DATE

FOR USE OF CON- TRACTING AGENCY ONLY	ITEM NO.	DESCRIPTION (IF PROPERTY HAS COMMERCIAL VALUE, FURNISH ADEQUATE COMMERCIAL DESCRIPTION. (SEE INSTR.) OTHERWISE, FURNISH DESCRIPTION SUFFIC- IENT TO ENABLE CONTRACTING OFFICER OR AUTHORIZED CONTRACTOR TO DETERMINE APPROPRIATE DISPOSITION THEREOF. WHERE FEASIBLE, SHOW MANUFACTURER'S NAME, ADDRESS AND CATALOG NUMBER. WHERE COLS. B1 AND B2 ARE NOT APPLICABLE, WRITE COL. B ENTRY ACROSS THE TWO COLS.)	GOVERNMENT PART OR DRAWING NUMBER AND REV. NUMBER	TYPE OF PACKING (BULK, BLS., SPATES, ETC.)	QUANTITY	UNIT OF MEASURE	COST		CONTRACTOR'S OFFER OR PROCEEDS OF SALE	FOR USE OF CON- TRACTING AGENCY ONLY
							UNIT	TOTAL		
	1	Pechan Prism	53990217	039	1	each				
	2	" "		042	1	"				
	3	Locking Ring			2	"				

INVENTORY SCHEDULE CERTIFICATE

The undersigned, individually and as an authorized representative of the Contractor, certifies that he has examined this Inventory Schedule, page numbers 1 to 1 inclusive, dated 5/22/67, and that in the exercise of his best judgment and to the best of his knowledge, based upon information believed by him to be reliable, said Schedule has been prepared in accordance with applicable instructions; that the inventory described therein is allocable to the designated contract and is located at the places specified; if the property reported therein is termination inventory, that the quantities are not in excess of the reasonable quantitative requirements of the terminated portion of the contract; that said Schedule does not include any items reasonably usable, without loss to the Contractor, on its

other work; that the costs shown on such Schedules are in accordance with the Contractor's books of account; and that the prices shown in column (g) representing the proceeds of authorized sale of the items covered thereby, are fair and reasonable.

The Contractor agrees to inform the Contracting Officer of any substantial change in the status of the inventory shown in this Schedule between the date hereof and the final disposition of such inventory.

Subject to any authorized prior disposition, title to the inventory listed in this Schedule is hereby tendered to the Government and is warranted to be free and clear of all liens and encumbrances.

TITLE
ControllerDATE
5/22/67

Manager, Product Cost Accounting

Approved For Release 2004/11/30 : CIA-RDP78B04770A000400020005-2

998415
750
2 JUNE

Recommended Contract Performance Specifications
Variable Anamorphic Eyepieces

1. Anamorphic ratio:

- a. Scale accuracy: The measured anamorphic ratios shall be within $\pm .03$ of the scale value for all midscale values. When the measured anamorphic ratio is 1 to 1, the scale value shall be 1 within $\pm .5$ mm. When the scale is set at 2.2 the measured anamorphic ratio shall be at least 2.15 to 1.
- b. Range: The ratio of the maximum obtainable anamorphic ratio to the minimum obtainable anamorphic ratio shall be at least 2.19.

2. Resolution:

When the eyepiece is tested in combination with any Zoom 70, the resolution reading at 1:1 anamorphic setting shall not be less than 90% of that Zoom 70's reading with the 10X widefield eyepiece with white light using a high contrast target (Black lines on a clear background) and tested as follows:

Set the pod magnification at 0.7 and focus on the target using a 5X auxillary telescope to magnify the image. Viewing the resolution block just above the highest block visible, gradually increase the pod magnification (and refocusing as necessary) until that block is just visible. Record the resolution reading as the quotient of the block lines per millimeter over the pod magnification at which the block in question just becomes visible.

3. Transmission:

When the eyepiece is tested in combination with any Zoom 70, the transmission reading at 1:1 anamorphic setting shall not be less than 1/4 of that Zoom 70's reading with the 10X widefield eyepiece with white light and tested as follows:

A circular beam of collimated white light equal in diameter (1.9mm) is directed into the instrument at the nominal exit pupil and the transmission is measured as the ratio of the amount of light energy emerging from the object end over the entering amount at that point where the bundle of light emerging from the object end is 1.9mm in diameter.

4. Magnification:

The magnification of the eyepiece shall be 10X $\pm 5\%$ when measured perpendicular to the stretch axis at any setting of the anamorphic controls.

-2-

5. Image Runout:

The image of a point at the center of the eyepiece object plane shall not run out more than 1mm TIR in the eyepiece image plane when the anamorphic axis orientation is rotated 360° at 1:1 anamorphic ratio.

6. Image Vignetting:

There shall be no noticeable vignetting at any position or value of the anamorphic controls.

7. Field Cut-In:

The amount of field cut-in observable when rotating the anamorphic axis orientation must not exceed .2mm in the eyepiece focal plane.

5/26/67